TAYLORIMYIA IOTA (JOHNSTON & TIEGS) (DIPTERA: SARCOPHAGIDAE), A PARASITOID OF *BIPRORULUS BIBAX* BREDDIN (HEMIPTERA: PENTATOMIDAE)

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Abstract

Taylorimyia iota (Johnston & Tiegs) is recorded parasitising adult and nymphal *Biprorulus bibax* Breddin in the Chinchilla district of southern Queensland. Egg-like structures (ELS) (1–22 per bug) were found attached to dorsal and ventral surfaces of up to 36% of *B. bibax* collected during spring-summer from *Eremocitrus glauca* (Lindl.) Swing. One male bug dissected in September 1998 contained a large maggot. One adult *T. iota* emerged in the laboratory from a female bug collected in November 1998. Five of 19 adult *B. bibax* with attached ELS collected in November 1998 and dissected after death, contained small maggots. In November 1998, adult *T. iota* were observed 'visiting' wild and caged *B. bibax*. Adult *B. bibax* confined in a glass tube with larvae that emerged from the abdomen of a damaged *T. iota*, carried ELS after three hours. Microscopic observations suggested *T. iota* larvae secreted these structures, presumably for protection, during entry into *B. bibax*. The biology and potential of *T. iota* as a natural enemy of *B. bibax* is discussed.

Introduction

The spined citrus bug, *Biprorulus bibax* Breddin, is an important pest of citrus in eastern Australia, causing internal staining/drying of fruit and fruit drop (Hely *et al.* 1982, James 1994a, Smith *et al.* 1997). Recent research on the biology and ecology of this native insect (e.g. James 1990a–c) led to development and adoption of an integrated management strategy based on monitoring, natural enemy conservation and judicious use of an insecticide (James 1994a).

The natural enemies of *B. bibax* recorded to date include 13 hymenopterous egg parasitoids (Summerville 1931, James 1990d, 1993a, Johnson 1991), an assassin bug, *Pristhesancus plagipennis* Walker (James 1994b, Smith *et al.* 1997), stink bugs, spiders, mantids, lacewings and ants (Smith *et al.* 1997). Smith *et al.* (1997: 110), using information supplied by the current author, state 'An unidentified tachinid fly parasitises adult spined citrus bugs in Queensland'. I here report the true identity of this fly as the sarcophagid *Taylorimyia iota* (Johnston & Tiegs) and provide information on this new parasitoid association for *B. bibax*.

Materials and Methods

All stages of *B. bibax* were collected from *Eremocitrus glauca* (Lindl.) Swing. (desert lime), during field studies of the natural enemy complex of *B. bibax* on its native host plant in inland southern Queensland. Sampling of bugs was conducted in the Mitchell/Muckadilla and Chinchilla districts in November 1990, November 1991 and January, September and November 1998. On the first visit to sampling sites in

November 1990, a number of adult bugs were found with small (approximately 1 mm x 0.5 mm), pale, egg-like structures (ELS) attached to their bodies (Fig. 1). Initially, these structures were erroneously assumed to be eggs of tachinid flies, well known parasitoids of adult stink bugs (Arnaud 1978). Data were recorded on the number of ELS per bug and their placement. These apparently parasitised bugs were taken back to the laboratory, held individually in plastic cups on immature citrus (lemon) fruit at 25–27°C and observed for emergence of parasitoids. Similar data were collected in 1991 and 1998. Bugs with ELS collected in November 1998 and held in the laboratory, were dissected under a stereomicroscope for evidence of parasitism following death. The ELS were also examined microscopically. A sample of bugs without ELS (n = 9) were dissected after capture in September 1998. In November 1998, flies were observed 'visiting' adult *B. bibax* in *E. glauca* bushes at one Chinchilla sampling site. Cages containing 20–40 bugs were positioned near the bushes in an attempt to attract these flies. Larvae that emerged from the accidentally damaged abdomen of one captured fly, were confined in a glass specimen tube with four adult, laboratory-reared *B. bibax*. The ELS subsequently found on these bugs were compared under a stereomicroscope with those found on wild bugs.

Results

1990: Ten (18%) of 55 adult *B. bibax* collected at Chinchilla on 26 November had 1–22 (mean 3.9 ± 2) ELS attached to their bodies (Fig. 1). All bugs with ELS were females. Twenty of the 39 ELS attached to the bugs were on the ventral surface, with the remainder attached dorsally. Two ELS were found under the hemelytra. ELS were frequently attached near the head of the bug or in the lower abdominal area and were often positioned on intersegmental membranes. No ELS were found on 63 bugs collected on 25 November from sites 200–250 km further west (Muckadilla, Mitchell). No parasitoids emerged from bugs held in the laboratory until their death.

1991: One female *B. bibax* of 47 collected in the Chinchilla district on November 6, carried a single ELS dorsally, near the head. No parasitoids emerged from this individual in the laboratory. No ELS were found on 32 bugs collected from sites at Mitchell and Muckadilla on 5 November.

1998: Five *B. bibax* (2 males, 3 females) of 75 collected from aestival clusters (James 1992) in *E. glauca* bushes at Chinchilla sampling sites on January 24, carried ELS. Each bug had a single ELS, positioned dorsally near the head or on the hemelytra. No parasitoids emerged from the bugs in the laboratory.

No ELS were found on nine *B. bibax* (6 females, 3 males) collected from Chinchilla sites on September 21. Dissection of these bugs (as part of a study on reproduction), revealed the presence of a single large (10 mm), dark brown maggot in one male (Fig. 1). Most of the fat body in this bug appeared to have been consumed by the maggot.

Fig. 1. (A) Egg-like structures (ELS) attached to adult *Biprorulus bibax*; secreted by first instar larvae of *Taylorimyia iota*. (B) Mature dipteran larva (assumed to be *Taylorimyia iota*) in opened abdomen of *Biprorulus bibax* collected at Chinchilla, southern Queensland in September 1998.

Eighteen (36%) of 50 *B. bibax* collected at Chinchilla sites on 5–6 November carried ELS. Eleven were females and 7 were males. In addition, two of 10 nymphs (one third and one fourth instar) collected carried single ELS. Adult bugs carried 1–3 (mean 1.4 ± 0.2) ELS and most (68%) were attached ventrally.

One sarcophagid fly, identified as *Taylorimyia iota* Johnston and Tiegs, emerged from a female *B. bibax* after 5 days at 27°C (specimen deposited in Agricultural Scientific Collections Unit, Orange Agricultural Institute). The remaining 17 adult bugs and two nymphs that carried ELS died after 1–49 days with no parasitoids emerging. Dissections revealed 5 of the 19 bugs (26%) contained single maggots which appeared to be alive. Maggots were pale in colour and ranged in size from 0.5–5 mm in length. Microscopic examination of the ELS showed most were 'kinked' and empty. However, two contained single, very small (< 1 mm) maggots that had apparently died before exiting the structure. Empty ELS had an 'exit hole' underneath and an apparent entry point on the bug, indicated by a diffuse dark coloured 'spot'. Twelve bugs showed no evidence of maggot presence and it is assumed that death of these maggots occurred shortly after entry.

On 5–6 November, flies were observed 'visiting' *B. bibax* located on the fruit/foliage of *E. glauca*. Weather conditions were sunny and hot (30–35°C). These flies also showed interest in bugs confined in cages and two individuals were captured. One fly was accidentally damaged on capture causing living maggots to issue from its abdomen. Confinement of these maggots with laboratory-reared adult *B. bibax* resulted in the discovery of two ELS on the dorsal surface of one bug when examined 3 hours later. Closer examination of the ELS showed they were cream-coloured and smooth, without the characteristic 'kink'. Re-examination three days later showed the ELS was now empty, paler and 'kinked'. There was also an 'exit hole' and apparent entry site on the exoskeleton of the bug.

Discussion

Host use in the Sarcophagidae is broad and includes millipedes, earthworms, snails and spider eggs as well as a number of insect families (Feener and Brown 1997). However, parasitism of adult pentatomids by sarcophagids appears to be uncommon with only the Nearctic species, *Sarcodexia sternodontis* (Townsend), previously reported as a parasitoid (Drake 1920). Six Australian pentatomids have been recorded as adult or nymphal hosts for at least seven species of Tachinidae (Cantrell 1984, 1986, Coombs and Khan 1997). However, adults and nymphs of Australian pentatomids appear to be infrequently parasitised by Diptera compared to other parts of the world (e.g. North and South America) where tachinids are important pentatomid parasitoids (Arnaud 1978, Buschman and Whitcomb 1980, McPherson *et al.* 1982).

This study has identified the existence of a host-parasitoid relationship between *B. bibax* and *T. iota*. The ELS found on adult and nymphal *B. bibax*, initially thought to be eggs of a tachinid parasitoid (Smith *et al.* 1997), are protective casings secreted by first instar larvae of *T. iota*, presumably to prevent dessication during the process of entering the bug. The protective casings presumably offer *T. iota* larvae similar protection to that afforded to tachinid larvae by their egg shells. Larviviparity is common in sarcophagids, and there is an obvious adaptive value in constructing a protective casing, given the harsh (hot, dry) environment of inland southern Queensland and the relatively tough exoskeleton of *B. bibax*.

More details on the biology of *T. iota* and its role in regulating populations of *B. bibax* await further study. In inland southern Queensland, *B. bibax* undergoes hibernal and aestival reproductive diapause (James 1991,1992, 1993b) and it is likely that *T. iota* has a corresponding physiology to ensure synchronisation with its host (Danks 1987). The presence of a mature dipteran larva, assumed to be *T. iota*, in a bug collected in early spring (September) suggests parasitism occurred the previous spring-summer. No ELS was present on this bug, suggesting that it had fallen off in the period since larval entry. Young larvae dissected from bugs collected in late spring (November) and the presence of adult flies at this time further supports the idea of a spring emergence of flies. *Biprorulus bibax* enter aestival dormancy in late November-December (James 1992). This may restrict *T. iota* to a single generation per year.

Taylorimyia iota is the first recorded parasitoid of adult and nymphal *B. bibax* and has potential importance as an addition to the natural enemy complex operating against this pentatomid (James 1993a, Smith *et al.* 1997). Currently, *T. iota* is known only from populations of *B. bibax* on *E. glauca* in the Chinchilla district of southern Queensland. It has not been reported from *B. bibax* on commercial citrus at Mundubberra-Gayndah, less than 100 km to the east of Chinchilla (Dan Papacek, pers. comm.), or anywhere else in Australia, despite extensive studies on the biology and management of this bug in recent years (see references in Smith *et al.* 1997). Further studies are needed on the biology of *T. iota* and its role in regulating *B. bibax* to determine whether there is value in introducing it to control *B. bibax* populations in commercial citrus. A survey of pentatomids in Australian insect collections might shed some light on possible other hosts of *T. iota*. Collectors could have assumed ELS on pentatomids were tachinid fly eggs.

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